THE ASTRONOMICAL METHODS OF THE ANCIENT MEXICANS.

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A WELL-KNOWN picture contained in the Codex Mendoza (Fig. 9, No. 1) represents a seated high-priest, whose vision is naïvely but graphically directed upwards to the symbol of the nocturnal heaven, consisting of a black semi-

FIG. 9.

circle which is studded with a number of eyes, i.e., stars. The commentator explains that the individual in question "is watch-

ing the stars at night, in order to know the hour, this being his particular function" (KINGSBOROUGH, Vol. v, p. 101). The above evidence, and the quaint statement on the previous page that the high-priest was "the clock-man by means of the stars of heaven," are corroborated by TEZOZOMOC's testimony. His "Cronica" (p. 574) contains a version of the solemn oration that was addressed to Montezuma the Younger after his election. In this he was exhorted not to neglect what is described as his most important duty; namely, to rise at midnight and to offer incense to certain principal stars. It was, moreover, customary for the priesthood in general to offer burning incense to the stars "after dusk, at about 3 A.M., and immediately before dawn," these divisions of time being marked by the sounding of drums or trumpets in the temples. While several authors have stated that the astronomer-priests of ancient Mexico habitually employed not only their pyramid temples, but also their ball-courts, as observatories, no one seems as yet to have bestowed especial attention upon a series of pictures contained in the Codices, which, however, furnish valuable evidence as to the *modus operandi* evolved by the native observers.

While the Codex Mendoza illustration merely shows an observer seated in the open air, the following eight pictures reveal that, as in the Old World, the ancient astronomers observed certain stars from a dark cell or chamber through the open doorway of their temples, which were invariably situated on an elevation. In Fig. 10, Nos. 2 and 3 (Borgian Codex, pp. 49 and 60), we have two instances of open doorways, in the centre of each of which a single star is figured. In the second of these illustrations, next to the temple, there is a circular symbol equally divided into two parts, one representing the nocturnal heaven; the other, the sun, or day. This symbol, which so clearly records an equal division of night and day, — i.e., the equinoctial period, — is supplemented by another sign, placed below the temple, which is frequently found employed to represent a great star or planet. In No. 4 (Fejervary, p. 34) twin-stars are figured in the doorway. Nos. 5 (Bologna 1), 6, and 7 (Vienna 8), as well as Nos. 8 and 9 (Vienna 41 and 6), exhibit door-

ways drawn in profile, this being the common conventional mode adopted by the native artists in their representations of temples. In Nos. 5, 6, and 7 a single star, in No. 8 an image of the sun, and in No. 9 a peculiar recurved sign studded with stars, and obviously representing a constellation, respectively occupy the doorway.

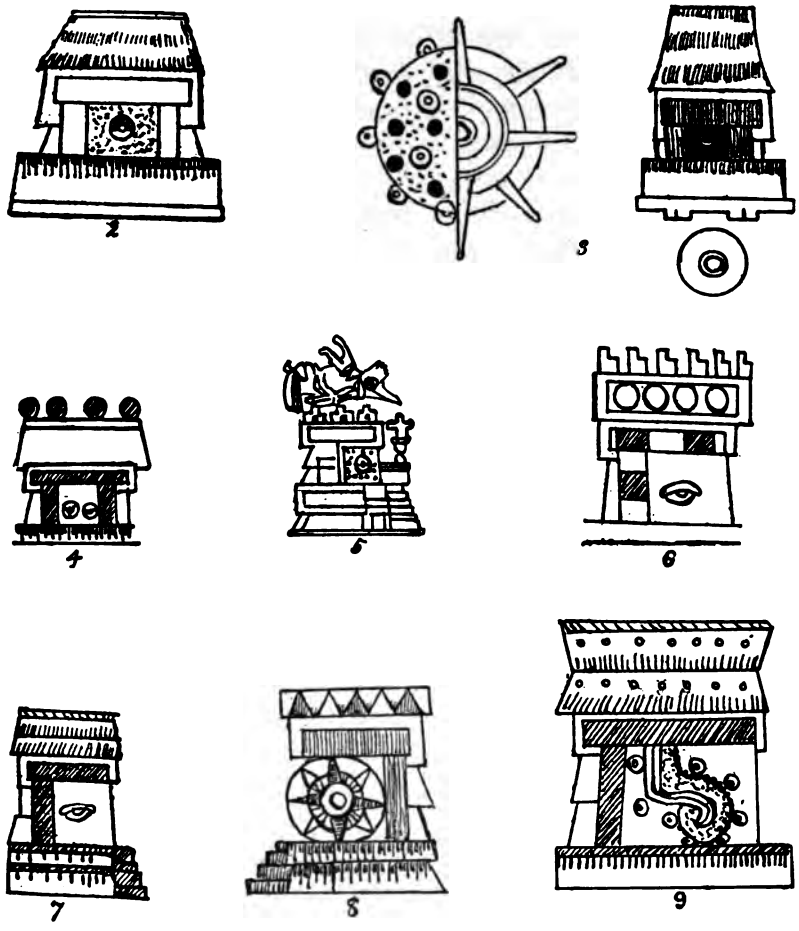

FIG. 10.

The indications furnished by the above native drawings are that some temples were oriented not only to the rising or setting sun, but also to certain stars or constellations whose appearance

in the centre of the doorway signified an exact date or period of the native year. The interesting fact that the Mexican astronomers did not confine themselves to observing the periodical shining of celestial bodies through openings in buildings, is revealed by the series of drawings which demonstrate the use of ingenious devices admirably adapted for the exact registration of the positions of stars.

Fig. 11, No. 10 (Vienna 7), represents a temple, on the roof and in the doorway of which rows of forked or bifurcated stakes are erected. The purpose for which this was done is revealed by the picture of a small temple No. 11 (Bodleian 28) which is unquestionably designated as a "star temple" by the three stars attached to its back wall. On its roof we perceive the conventional sign for "star" lodged in the bifurcation of a stake, the same combination recurring in Nos. 13 (Selden 14), 12, and 14 (Bodleian 32 and 15). No. 12 is of particular interest, because the temple walls and roof are studded with six stars, and a human face or mask is depicted in the act of peering out of the doorway, in front of which cross-sticks are set up. No. 14 is equally instructive; for besides exhibiting, as in No. 13, a star lodged in the triangle formed by the forked stake erected at the summit of the temple stairway, it shows a large star resting on the roof exactly between the terraced corners of the edifice. A conventionalized four-petalled flower is painted on the lintel of the temple door. A proof that this was the actual sign for a certain star is furnished by No. 17 (Bodleian 16), which exhibits this identical flower on the band studded with stars, denoting the nocturnal heaven. In No. 15 (Bodleian 17) the same star-band is painted above a footprint directed downwards, in proximity to a seated figure accompanied by day and year signs. While it is possible that this iconomatic sign may have expressed the word *Citlal-temoc* ("descending star"), this being the name of the individual, it is not impossible that it may have recorded the setting of some particular star on the date recorded. A similar footprint directed away from the temple in No. 14 (Bodleian 15) suggests that the doorway may have faced the east, that the footprint

referred to the setting of the "Flower" star or of the adjacent constellation which figures in the original. No. 22 (Bodleian 6) furnishes another instance of the combination of the Flower sign, a star symbol, and of a footprint directed downwards. In

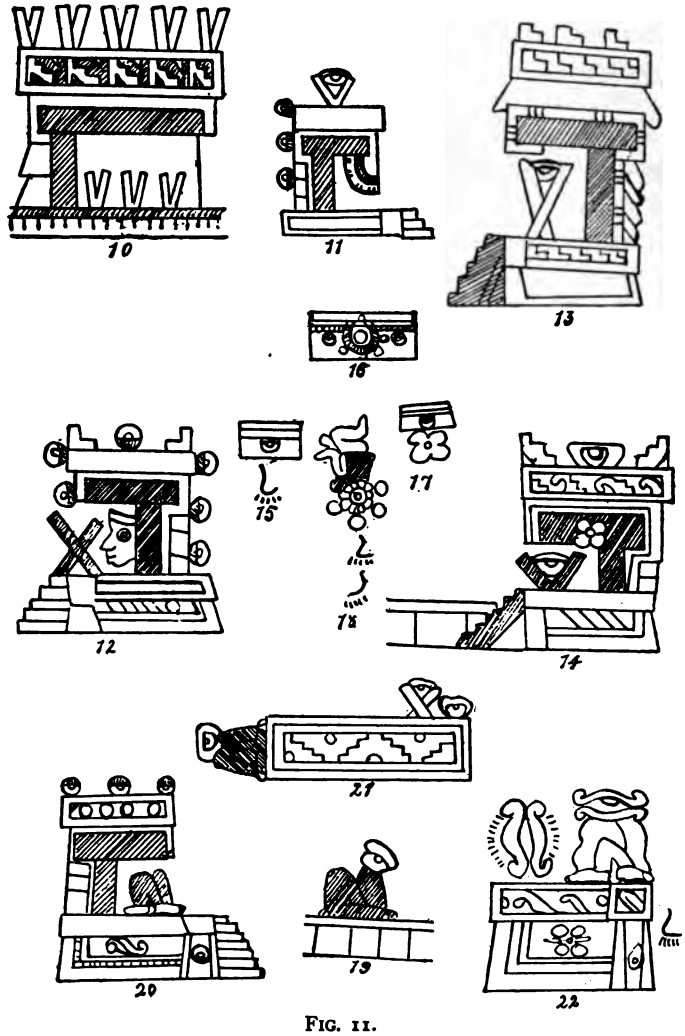

FIG. 11.

this case the edifice associated with these signs is like a flat terrace, on the top of which is a curious device which not only resembles the drawn-up limbs of a seated human figure, but

actually represented these, as proved by No. 23 (Bodleian 36), in which the human foot and sandal are clearly delineated. This device appears to have served the same purpose as the bifurcated stakes; for, surmounted by a star, it figures in temple doorways, etc., in the same way as the latter. In No. 21 both devices are represented together in identical connection with stars, in the same illustration.[1] The "knee-sign" also recurs in the doorway of the temple No. 20 (Bodleian 16), which also displays three stars on its roof, another on the wall near the stairway, and a constellation sign in a panel. The same codex (p. 20) contains a similar temple (Fig. 9, No. 20 b), but, in the place of the knee-sign, the bifurcated stake, with a star resting in its fork, occupies the doorway. In front of this star-temple, on a panel decorated with a geometrical design, are seated, opposite to each other, a priest exhibiting the mask of the rain-god and the emblem of the sun, and a woman, presumably a priestess. As in a number of instances contained in the same codex, both personages are pointing to the star in the forked stick which rests between them. A footprint painted above the star, and directed towards the temple, may have conveyed the fact that the latter faced the east, whence the star appeared to travel towards its doorway. It is noteworthy that, whereas in Fig. 11, Nos. 21 and 22, a star is figured as resting on both knees, No. 19 (Bodleian 22 a) exhibits a star poised on one knee only, the knee-sign and star being also situated between the seated figures of a man masked as an ocelot and a woman.[2] In Fig. 9, No. 22 b, a star-circle or constellation identical with that depicted in Fig. 11, No. 16, is likewise represented above a single knee.

While the above data establish the fact that the forked staffs and the peculiar knee-figures were equally employed to register the positions of stars (presumably with differences of meanings

[1] The homonymy of the first syllable of the Nahuatl word for "knee" (*tlanquaitl*) and the word for "below or underneath" suggests that, in connection with stars, the knees may have been adopted as an iconomatic sign expressing their periodical disappearance.

[2] In this connection it is interesting to note that the Nahuatl word signifying "on the knee" is *tlanquaticpac*, which can be read as a homonym conveying the meaning "on the summit or head of the earth or land."

known to the initiated), there exist a few pictures which appear to indicate the use of rows of upright stakes, such as are represented in Fig. 12, No. 24 (Selden 9). There is, however,

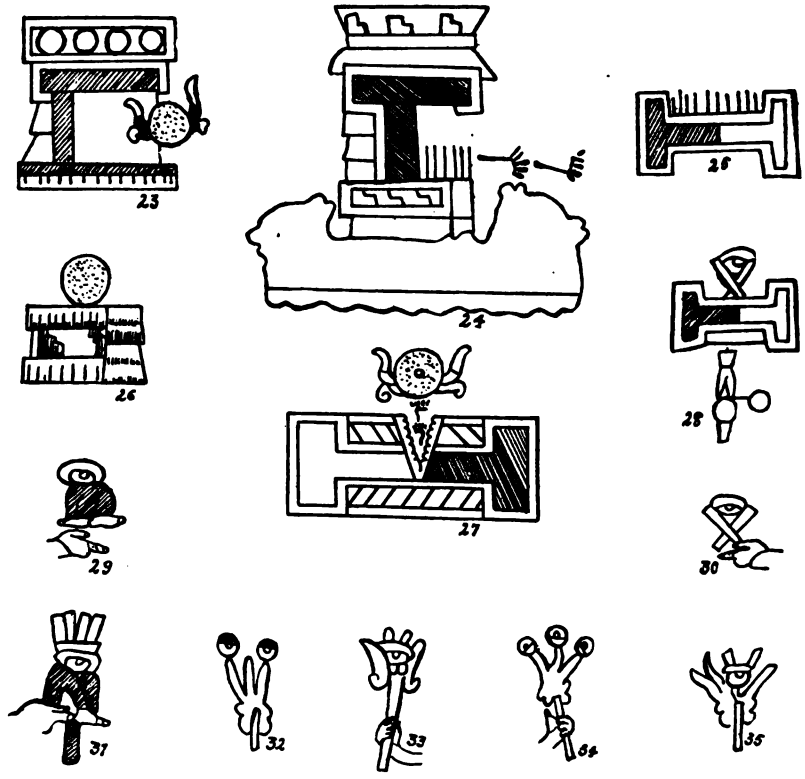

FIG. 12.

the possibility that the row of perpendicular lines signified the numeral *tzontli* ("four hundred"), which the native scribes recorded by various representations of its homonym *tzontli* ("hair"). In either case the perpendicular "sticks" or "hairs," and the footprint beside them, appear to bear direct relation to the conspicuous constellation depicted immediately behind the temple, which is situated on the conventional sign for "mountain." Whether the lines denoted hairs and recorded the number of times the star was observed to move away from the temple, or whether they represented a device for

observing its course, they are equally interesting. The latter interpretation is encouraged by the fact that p. 5 of the Selden MS. presents two instances of their use in exactly the same positions as the bifurcated stakes; namely, on the top of one of the side-walls of the native ball-court. The ground-plan of this, shaped like a double *tau*, constitutes the familiar sign for the word *tlachtli*, which signified the game of ball as well as the court in which it was played. Fig. 12, No. 25, reproduces one of the two *tlachtlis* figured with the row of perpendicular lines. No. 28 reproduces the second of the two *tlachtlis* on the same page, which exhibit, on the same wall, bifurcated stakes with stars. In this case the *tlachtli* is accompanied by the calendar-sign one *acatl* ("cane"); in the other, by the day-sign one *coatl* ("serpent"). Further evidence proving that the same side-wall was employed for astronomical observations, and that particular note was made of the time when a certain star rose behind its exact centre, is furnished by No. 27 (Vienna 19). This positively demonstrates, moreover, that the star observed in its case was the *Citlalpul* or *Huey citlalin* ("the Great or Ancient Star"), the planet Venus, as morning star. Its sign is rendered here as a large dish with two wing-like appendages, which represent its radiance or light, the intention being to depict the planet at its period of greatest brilliancy. According to SAHAGUN'S Laurentian MS., "when this star made its appearance in the east, they sacrificed captives in its honor and offered blood, fillipping it with their fingers towards the star." No. 23 seems to furnish proof that the heliacal rising of the planet was also observed through the doorways of temples oriented to the east. The planet, minus the wing-like appendages, i.e., at a different period of its revolution, is figured in No. 26 (Vienna 39), on the top of a truncated pyramid (cf. Fig. 11, No. 22).

Attention is finally drawn to the curious fact that in the Bodleian and Selden MSS., the contents of which mainly deal with astronomical phenomena and festivals, a number of personages, usually associated with other star-signs, are represented as holding in one hand the forked stakes and star or the knee-figure

and star Nos. 34, 29, and 30 (Bodleian 19). In other cases they hold what appear to be symbolical sceptres, probably pertaining to periodical star festivals. Many of these exhibit one, two, or three stars placed between, as in Nos. 32 and 35 (Bodleian 17), or on the tips of the two or three pointed sceptres, as in Nos. 31 and 33 (Bodleian 17).

It would carry me too far to discuss here the numerous instances in which the forked stick and star are represented on the backs or heads of certain animal and bird forms under which the ancient Mexicans figured some of their principal constellations. Although the foregoing illustrations constitute merely a part of the material I have been collecting on the subject, they will suffice to establish beyond a question the hitherto undemonstrated fact that the ancient Mexicans not only employed their carefully oriented temples and ball-courts as astronomical observatories, but also invented ingenious devices for accurately registering the periodical appearances or disappearances of important celestial bodies.

The above material would be wofully incomplete, however, if no mention were made of the existence of documentary evidence — furnished by Friars Duran and Motolinia, the historian Ixtlilxochitl, the Anonymous Author of the Biblioteca Nazional MS., and other writers — proving that the Mexican sun-priests were acquainted with the use of the gnomon, and possessed an accurate knowledge of the equinoxes and solstices.

One aim of this brief monograph will be attained if it establishes, that in pre-Columbian America, as in the Old World, countless generations of men spent wakeful nights in silence and solitude, patiently, earnestly studying the heavens, and, seized by an awakening spirit of scientific research, resorted to the systematic and exact observations and registration of the movements of celestial bodies. The actual purpose of the present communication will, however, be fulfilled only when, by its presence in this festive volume, it shall yield testimony of my high esteem for my honored colleague Dr. Franz Boas, and of my sincere appreciation of the great and permanent value of his scientific contributions.